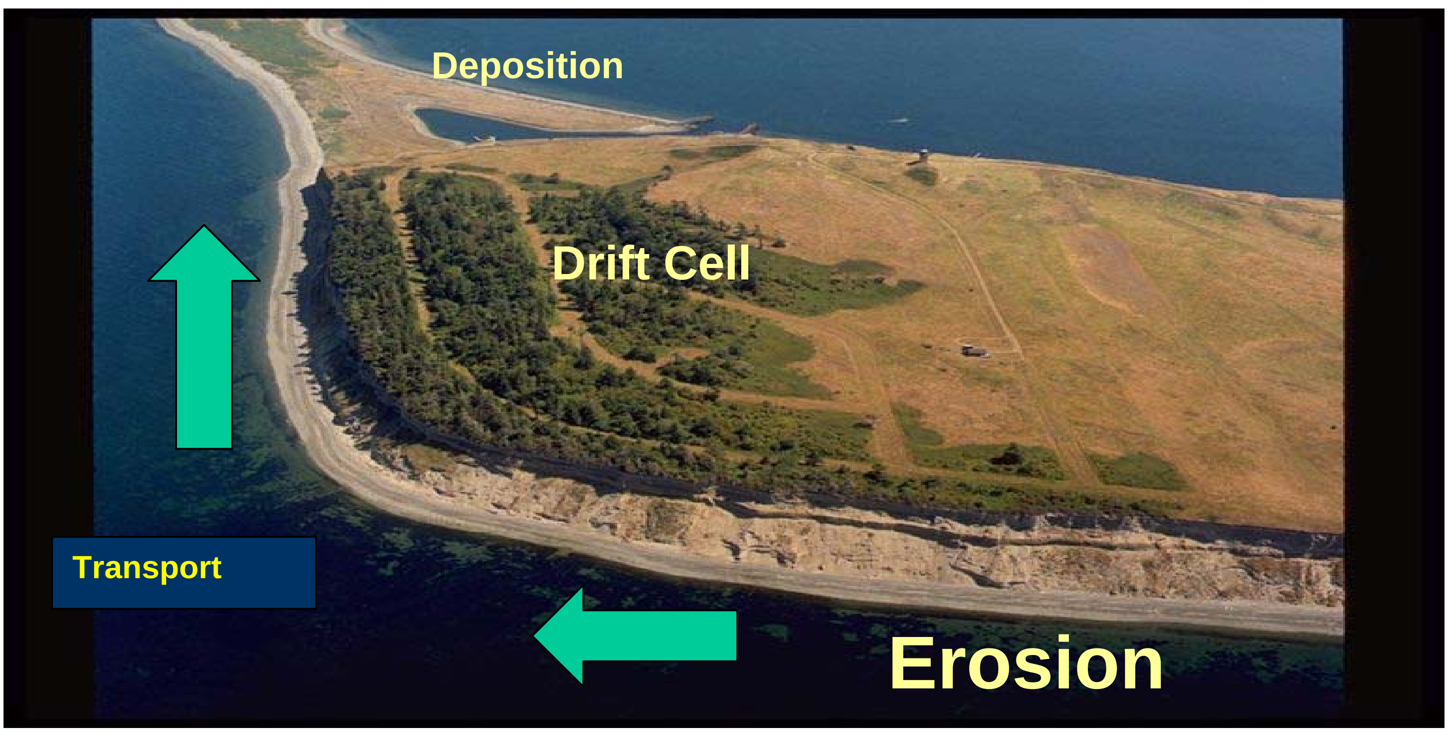
Appendix C
Methods and mapping procedures for drift cell analysis

Background and assumptions:

Following the salmon conceptual model, smaller life history types of juvenile salmon need shallow, low-gradient shorelines for rearing. These types of shorelines occur within embayments (pocket estuaries) and deltas. Larger life history types need a variety of landscapes including the above plus more open shorelines with stronger wave action. Bull trout have been documented to have a primary association with sand and gravel spits, a depositional feature near the mouths of many pocket estuaries. The complex structure of nearshore environments is an interplay of several important processes.

At the larger scale, it is useful to understand the fundamental processes of sediment delivery and transport. While most people are familiar with the fact that sediments are transported downstream in rivers to form deltas at their mouths, longshore sediment transport is less fully understood. The fundamental unit of longshore sediment transport is known as a “drift cell” where waves and currents cause localized erosion, carry sediments for some distance down the beach in a predictable net direction and deposit them when the wave energy is insufficient to keep the particles suspended. (reference Terich) The picture below describes a “typical” drift cell with erosional, transport and depositional sections.



According to the draft nearshore typology being developed by Hugh Shipman for Puget Sound Nearshore Ecosystem Restoration Project (PSNERP), Puget Sound beaches operating within the sub-basin scale being used in this chapter fall into two basic types: bluff-backed beaches and barrier beaches. Bluff-backed beaches are defined by Shipman to be generally erosional in nature and barrier beaches are generally depositional in nature. Smaller scale beaches are defined elsewhere in Shipman's typology but those are better suited for finer scale analysis.

See **figure 1** for an example of a "typical" bluff-backed erosional beach. The physical appearance of a bluff-backed beach from an aerial photo does not necessarily indicate whether or not it is an erosional feature. Sometimes recent landslides and lack of vegetation indicate active erosion. Rather, its location in the drift cell is more informative. **Figure 2** shows a bluff-backed beach with a low, erosional scarp not typical of a bluff as most people know it.

Likewise, depositional beaches may be in the form of low sand and gravel spits (**Figure 3**) or wide sandy beaches situated in front of a tall bluff that has been stabilized (**Figure 4**). Again, the presence of the bluff is less determinant of type than the location within the drift cell.

This drift cell analysis proceeds from the assumption that, at the grossest scale, drift cells contain both erosional and depositional features. These two types of beaches are logically linked into interconnected units by the littoral drift cell because the material that deposits on barrier beaches is assumed to derive from sediment eroding within the same drift cell. Near large estuarine deltas and pocket estuaries with significant freshwater influence, additional deltaic sediments may be incorporated into the littoral drift system and deposited at the mouths of embayments. This method of mapping is not intended to draw strict boundaries between these two processes but instead to consider where both deltaic and longshore processes might be working in concert to produce a shoreline landform.

Areas of shoreline with rocky substrate are assumed to not be subject to the action of littoral drift cells because longshore drift processes have little affect on beach substrate and structure along rocky shorelines. Secondary stressors like adjacent land use on rocky shorelines may affect salmon but were not evaluated in this analysis.

Methodology and description of map symbols:

Mapped drift cells for Puget Sound (cite Ecology data layer) were linked on GIS with DNR Shorezone coverage of relative shoreline armoring. The two layers were then displayed on a Digital Elevation Model base map of Puget Sound. Drift cells of less than one mile in length were masked so that analysis could occur at the largest scale of drift cell function within the sound.

Drift cells with large amounts of armoring (Shorezone red lines) were considered for their degree of function and ability to be restored. For example, in cases where large amounts of armoring are present, secondary land uses were evaluated by viewing Ecology's digital coastal atlas and oblique aerial photo sets for corresponding geography. In some cases, the armoring was the only stressor and removal of the armoring should be expected to restore many of the historic functions of the shoreline. Some shorelines with large amounts of armoring occur in deltaic shorelines like the Skagit, and therefore are expected to impair intertidal functions while others are part of the littoral drift system and presumed to impair longshore sediment transport patterns. Differences in impairment for various shoreline segments are discussed in the sub-basin assessments.

In other cases, the high level of armoring is treated as a surrogate for other shoreline stressors like stormwater and sewage discharge, industrial legacy, and proximity to continued urban growth. These shorelines are considered barriers to migration and have no boxes associated with them on the map. Additional landscape metrics such as continuity of natural or disturbed shoreline may need to be employed to ascertain whether barriers to migration represent a stressor to salmon. Drift cells corresponding with small (Shorezone green lines) or moderate (Shorezone yellow lines) amounts of armoring were also explored using Ecology's digital coastal atlas and oblique aerial photo sets.

Boxes were drawn to include the entire drift cell or multiple drift cells with net shore drift moving in the same direction. Boxes were also drawn around areas of drift cell divergence to accommodate the erosional and depositional areas of both drift cells. The general color scheme is green for protection, yellow for restoration, rust for upland sediment sources and black for special circumstances such as consideration of beach nourishment.

Green boxes indicate areas of little armoring or other adjacent land use that would be detrimental to shoreline function. Shorelines located within green boxes should therefore be considered for conservation opportunities within shoreline master programs, critical areas ordinances, and stewardship programs.

Yellow boxes denote shorelines with significant current function but depositional features at risk if further armoring and associated land development occurs. These areas are recommended for finer scale analysis. It may be possible to protect important depositional features by restoring erosional and transport processes at a smaller scale.

Rust colored boxes were drawn from the shoreline to several miles inland along the coastal drainage to indicate that upland sediment sources should be protected in addition to longshore sediment transport processes in order to sustain the depositional features within the nearshore. It is evident from viewing oblique aerial photos that the depositional features near the mouths of large river deltas and pocket estuaries with significant freshwater influence contain elements of both deltaic and longshore processes.

Finally, I employed local knowledge of situations in certain large drift cells that result in **"black box"** or special case mapping. For example, the Elwha drift cell from the mouth of the Elwha River to the end of Ediz Hook in Port Angeles is expected to become the beneficiary of new sediment delivery after the Elwha dams are removed. However, the current state of armoring and local proposals to increase that armoring may soon change the structure of this drift cell to the point that it is not capable of receiving the new sediment. In this case, beach nourishment should be considered as an alternative to armoring.

Maps of each sub-basin are contained in **Appendix E** with descriptions accompanying each of the color-coded and numbered drift cell boxes.

Figure 1

Figure 2

Figure 3

Figure 4